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The synthetic pathway leading to 4-*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepines is described in five steps starting from 2-hydroxyketones *via* 2-amino-3-furonitriles.

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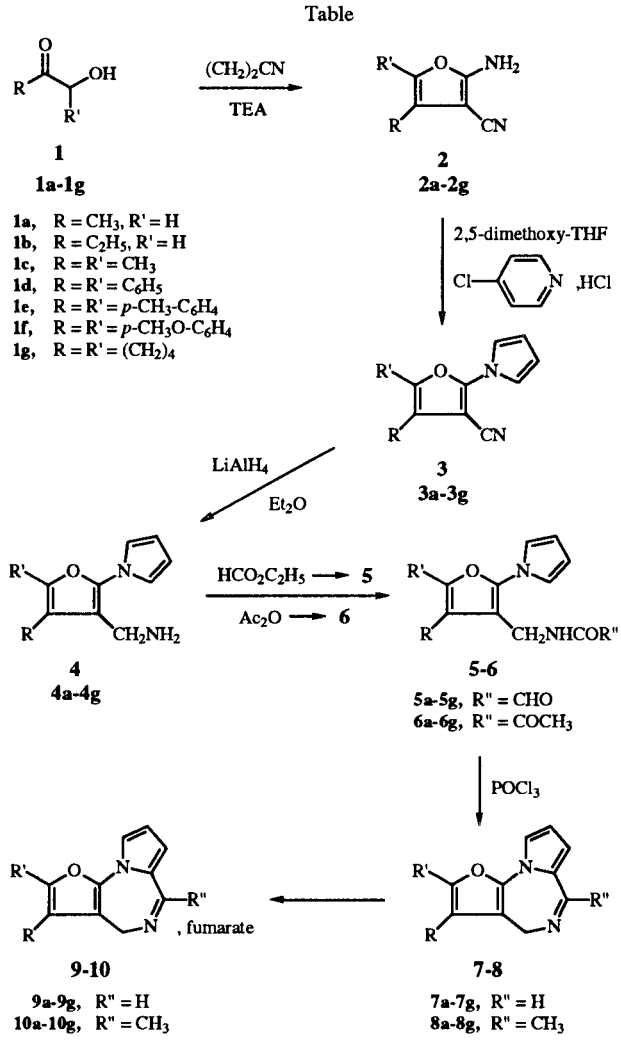
In continuation of our work concerning the synthesis and biological evaluation of new triheterocyclic system derivatives such as pyrrolothienodiazepines [1-5], pyrrolothienopyrazines [6-7], thienopyrolizines [8], we describe herein the synthesis of the first representatives of a new system 4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine in which one replaces the thiophene of pyrrolothienodiazepines by a furan ring. These new compounds were obtained in five steps starting from α-hydroxyketones **1** which, according to the method of Gewald [9], gave by reaction with malononitrile in the presence of a base the corresponding 2-amino-3-furonitriles **2** bearing in 4 or/and 5 positions an alkyl or aryl substituent. It is noted that this method remains limited to the preparation of very few compounds, because the cyclisation of 2-hydroxyketones with malononitrile into aminofuran derivatives competes with the formation of hydroxypyrroles which can become predominant depending on their substitutions in many cases [9]. However, application of this method prompted us to prepare compounds **2a-d** in a satisfactory yield. Further, modification of this method by replacing ethanol with dimethylformamide and triethylamine with diethylamine allowed us to prepare the not yet described compounds **2e** and **2f** in high yield (90%).

On the other hand the lack of stability of these aminofuran derivatives in acidic medium in which they very easily produce the corresponding lactones render their use difficult. This unstability led us to examine in detail the conditions of application of the method of Clauson Kaas [10] to form the pyrrolyl derivatives **3**.

The best conditions were discovered to be the following: reaction of 2,5-dimethoxytetrahydrofuran with **2** in anhydrous dioxane under argon in the presence of 0.5 equivalent of 4-chloropyridinium chloride at 70° during 30 minutes. After a conventional work up **3** were obtained in about 40% yield. Then after this key step the sequence was quite conventional hydrogenation of the cyano group of compounds **3** with lithium aluminiumhydiride in boiling ether gave aminomethyl derivatives **4** in about 50% yield, acylation of these latter with ethyl formiate or acetic anhydride furnished respectively the formamides **5** and the acetamides **6**. Cyclisation of these amides was finally achieved in phosphorylchloride at 40° for 4 hours to give the furopyrrolodiazepines **7** and **8**; these compounds are stable solids which can be salified to give more water soluble salts such as fumarates **9** and **10**.

Further investigations concerning the title compounds are currently carried on, particularly the reinvestigation of the preparation of new aminofuran derivatives which could permit the extent of this study. Biological evaluation of compounds **7-10** is in progress.

Table



## EXPERIMENTAL

Melting points were taken on a Köfler block and are uncorrected. Infrared spectra were recorded on a Philips PU 9716 apparatus and only noteworthy absorptions (reciprocal centimeters) are listed. The nmr spectra were recorded on a Perkin Elmer 90 G using TMS as an internal standard. Chemical shifts are reported in ppm downfield (δ) from TMS.

2-Amino-3-furonitriles **2a-f**.

The synthesis of compounds **2a**, **2c**, **2d** and **2g** is described in ref [9].

2-Amino-4-ethyl-3-furonitrile (**2b**).

To a solution of 1-hydroxy-2-butanone (2.12 g, 0.024 mole) and malononitrile (1.85 g, 0.028 mole) in methanol (10 ml) was added slowly during 30 minutes triethylamine (2.5 ml) at such a rate that the temperature stayed below 40°. The mixture that reacted was then stirred at room temperature for 4 hours and poured into water (100 ml). The resulting precipitate was filtered, washed with water and dried. Crystallization from diethyl ether gave orange crystals, 2.7 g (82%), mp 90°; ir (potassium bromide): ν 3430, 3340 ($NH_2$), 2200 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.17 (s, 2H, $NH_2$), 6.70 (s, 1H, $H_5$), 1.87 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_7H_8N_2O$: C, 61.75; H, 5.92; N, 20.58. Found: C, 61.82; H, 5.90; N, 20.60.

2-Amino-4,5-di-*p*-toluyl-3-furonitrile (**2e**).

To a solution of 4,4'-dimethylbenzoin (6 g, 0.025 mole) and malononitrile (2 g, 0.030 mole) in dimethylformamide (15 ml) was added slowly during 30 minutes diethylamine (10 ml) at such a rate that the temperature stayed below 40°. The mixture that reacted was then stirred at room temperature for 18 hours and poured into water (100 ml). The resulting precipitate was filtered, washed with water and dried. Crystallization from diethyl ether gave yellow crystals, 6.8 g (94%), mp 216°, ir (potassium bromide): ν 3440, 3280 ($NH_2$), 2200 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.57 (s, 2H, $NH_2$), 7.23 (m, 4H, $C_6H_4$), 7.10 (m, 4H, $C_6H_4$), 2.37 (s, 3H, $CH_3$), 2.23 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{19}H_{16}N_2O$: C, 79.14; H, 5.59; N, 9.72. Found: C, 79.20; H, 5.41; N, 9.82.

2-Amino-4,5-di-*p*-anisyl-3-furonitrile (**2f**).

Following the same procedure as for the synthesis of **2e** with 4,4'-dimethoxybenzoin (6.8 g, 0.025 mole) the reaction gave yellow crystals of **2f**, 7.15 g (89%), mp 206°; ir (potassium bromide): ν 3440, 3280 ($NH_2$), 2210 (C≡N) $cm^{-1}$; $^1H$-nmr (dimethyl sulfoxide-$d_6$): δ 7.50 (s, 2H, $NH_2$), 7.10 (m, 8H, 2 x $C_6H_4$), 3.77 (s, 3H, $CH_3$), 3.67 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{19}H_{16}N_2O_3$: C, 71.23; H, 5.04; N, 8.75. Found: C, 71.40; H, 5.10; N, 8.82.

2-(1-Pyrrolyl)-3-furonitriles (**3a-f**).

General Procedure.

A solution of 2-aminofuronitrile (**2**) (0.02 mole), dimethoxytetrahydrofuran (0.02 mole) and 4-chloropyridinium chloride (0.01 mole) in dioxane (50 ml) was heated at 70° under argon for 0.5 hour. The dioxane was then evaporated under reduced pressure, and the residue was dissolved in diethyloxide (200 ml), the ethereal layer was washed in water (3 x 200 ml) dried over magnesium sulfate and decolorized with charcoal. Diethyl ether was removed, and the residue was either recrystallized for solid compounds or directly engaged in the following step without further purification for oily compounds.

4-Methyl-2-(1-pyrrolyl)-3-furonitrile (**3a**).

The yield was 1.03 g (30%) (yellow oil); ir (potassium bromide): ν 2238 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.23 (m, 3H, $H_{2'}$, $H_{5'}$ and $H_5$), 6.30 (t, 2H, $H_{3'}$ and $H_{4'}$), 2.07 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{10}H_8N_2O$: C, 69.75; H, 4.68; N, 16.27. Found: C, 69.90; H, 4.72; N, 16.30.

4-Ethyl-2-(1-pyrrolyl)-3-furonitrile (**3b**).

The yield was 0.94 g (25%) (yellow oil); ir (potassium bromide): ν 2220 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.51 (s, 1H, $H_5$), 7.35 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.41 (t, 2H, $H_{3'}$ and $H_{4'}$), 2.47 (q, 2H, $CH_2$), 1.20 (t, 3H, $CH_3$).

*Anal.* Calcd. for $C_{11}H_{10}N_2O$: C, 70.95; H, 5.41; N, 15.05. Found: C, 70.80; H, 5.46; N, 15.15.

4,5-Dimethyl-2-(1-pyrrolyl)-3-furonitrile (**3c**).

The yield was 2.25 g (60%) (yellow solid), mp 84-86°; ir (potassium bromide): ν 2200 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 6.43 (t, 2H, $H_{2'}$ and $H_{5'}$), 5.53 (t, 2H, $H_{3'}$ and $H_{4'}$), 1.43 (s, 3H, $CH_3$), 1.20 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{11}H_{10}N_2O$: C, 70.95; H, 5.41; N, 15.05. Found: C, 70.91; H, 5.45; N, 15.10.

4,5-Diphenyl-2-(1-pyrrolyl)-3-furonitrile (**3d**).

The yield was 5.27 g (85%) (yellow solid), mp 136°; ir (potassium bromide): ν 2220 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.4 (m, 12H, $H_{2'}$, $H_{5'}$ and 2 x $C_6H_5$), 6.40 (t, 2H, $H_{3'}$ and $H_{4'}$).

*Anal.* Calcd. for $C_{21}H_{14}N_2O$: C, 81.27; H, 4.55; N, 9.03. Found: C, 81.30; H, 4.60; N, 9.13.

4,5-Di-*p*-toluyl-2-(1-pyrrolyl)-3-furonitrile (**3e**).

The yield was 5.88 g (86%) (yellow solid), mp 166°; ir (potassium bromide): ν 2210 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.47 (t, 2H, $H_{2'}$ and $H_{5'}$), 7.20 (m, 8H, 2 x $C_6H_4$), 6.43 (t, 2H, $H_{3'}$ and $H_{4'}$), 2.33 (s, 3H, $CH_3$), 2.20 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{23}H_{18}N_2O$: C, 81.63; H, 5.36; N, 8.28. Found: C, 81.70; H, 5.41; N, 8.30.

4,5-Di-*p*-anisyl-2-(1-pyrrolyl)-3-furonitrile (**3f**).

The yield was 5.0 g (67%) (yellow solid), mp 124°; ir (potassium bromide): ν 2220 (C≡N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.17 (m, 10H, 2 x $C_6H_4$, $H_{2'}$ and $H_{5'}$), 6.43 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.78 (s, 3H, $CH_3$), 3.70 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{23}H_{18}N_2O_3$: C, 74.58; H, 4.90; N, 7.57. Found: C, 74.62; H, 5.00; N, 7.62.

1-[2-(1-Pyrrrolyl)-3-furyl]methylamines **4a-f**.

General Procedure.

A solution of furonitrile **3** (0.005 mole) in anhydrous diethyl ether (200 ml) was slowly added to a solution of lithium aluminium hydride (0.01 mole) in anhydrous diethyl ether (200 ml) and then the mixture that reacted was heated at reflux for 3 hours and after cooling in an ice bath, it was carefully poured in water (30 ml). The mineral salts were filtered, the ethereal layer was washed with water, dried over magnesium sulfate and

decolorized with charcoal. Diethyl ether was evaporated under reduced pressure to give compounds **4** as oils, which were used without further purification in the following step.

1-[4-Methyl-2-(1-pyrrolyl)-3-furyl]methylamine (**4a**).

The yield was 0.52 g (60%) (yellow oil); ir (potassium bromide): ν 3361, 3285 ($NH_2$) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.25 (s, 1H, $H_5$), 6.95 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.30 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.65 (s, 2H, $CH_2$), 2.07 (s, 3H, $CH_3$), 1.22 (broad, 2H, $NH_2$).

*Anal.* Calcd. for $C_{10}H_{12}N_2O$: C, 68.15; H, 6.87; N, 15.90. Found: C, 68.30; H, 6.90; N, 16.00.

1-[4-Ethyl-2-(1-pyrrolyl)-3-furyl]methylamine (**4b**).

The yield was 0.38 g (40%) (brown oil); ir (potassium bromide): ν 3380, 3300 ($NH_2$) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.14 (s, 1H, $H_5$), 6.99 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.21 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.47 (s, 2H, $CH_2$), 2.49 (q, 2H, $CH_2$), 2.31 (broad, 2H, $NH_2$), 1.18 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{11}H_{14}N_2O$: C, 69.44; H, 7.42; N, 14.73. Found: C, 69.46; H, 7.51; N, 14.82.

1-[4,5-Dimethyl-2-(1-pyrrolyl)-3-furyl]methylamine (**4c**).

The yield was 0.64 g (68%) (yellow oil); ir (potassium bromide): ν 3350; 3280 ($NH_2$) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 6.87 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.23 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.60 (s, 2H, $CH_2$), 2.20 (s, 3H, $CH_3$-5), 2.00 (s, 3H, $CH_3$-4), 1.20 (broad, 2H, $NH_2$).

*Anal.* Calcd. for $C_{11}H_{14}N_2O$: C, 69.44; H, 7.42; N, 14.73. Found: C, 69.49; H, 7.51; N, 14.86.

1-[4,5-Diphenyl-2-(1-pyrrolyl)-3-furyl]methylamine (**4d**).

The yield was 1.41 g (90%) (brown oil); ir (potassium bromide): ν 3440, 3360 ($NH_2$) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.0 (m, 12H, 2 x $C_6H_5$, $H_{2'}$ and $H_{5'}$), 6.30 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.20 (s, 2H, $CH_2$), 1.50 (broad, 2H, $NH_2$).

*Anal.* Calcd. for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91. Found: C, 80.33; H, 5.82; N, 8.90.

1-[4,5-Di-*p*-toluyl-2-(1-pyrrolyl)-3-furyl]methylamine (**4e**).

The yield was 1.60 g (93%) (yellow oil); ir (potassium bromide): ν 3430, 3370 ($NH_2$) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.2 (m, 10H, 2 x $C_6H_4$, $H_{2'}$ and $H_{5'}$), 6.33 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.30 (s, 2H, $CH_2$), 2.40 (s, 3H, $CH_3$), 2.27 (s, 3H, $CH_3$), 1.57 (broad, 2H, $NH_2$).

*Anal.* Calcd. for $C_{23}H_{22}N_2O$: C, 80.67; H, 6.48; N, 8.18. Found: C, 80.72; H, 6.60; N, 8.21.

1-[4,5-Di-*p*-anisyl-2-(1-pyrrolyl)-3-furyl]methylamine (**4f**).

The yield was 1.42 g (76%) (yellow oil); ir (potassium bromide): ν 3460, 3400 ($NH_2$) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 6.9 (m, 10H, 2 x $C_6H_4$, $H_{2'}$ and $H_{5'}$), 6.20 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.70 (s, 3H, $CH_3$), 3.60 (s, 3H, $CH_3$), 3.43 (s, 2H, $CH_2$), 1.43 (broad, 2H, $NH_2$).

*Anal.* Calcd. for $C_{23}H_{22}N_2O_3$: C, 73.77; H, 5.92; N, 7.48. Found: C, 73.80; H, 5.88; N, 7.58.

*N*-[{2-(1-Pyrrolyl)-3-furyl}methyl]formamides **5a-f**.

General Procedure.

A solution of compound **4** (0.01 mole) in ethyl formate (30 ml) was heated at reflux for 10 hours. The mixture that reacted was then left to cool overnight, the crystalline precipitate was finally filtered, washed with diethyloxide and dried to give **5**.

*N*-[{4-Methyl-2-(1-pyrrolyl)-3-furyl}methyl]formamide (**5a**).

The yield was 0.41 g (20%) (white crystals), mp 124°; ir (potassium bromide): ν 3280 (NH), 1645 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.00 (t, 1H, NH), 7.90 (s, 1H, CH), 7.30 (s, 1H, $H_5$), 7.00 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.21 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.00 (s, 2H, $CH_2$), 1.90 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{11}H_{12}N_2O_2$: C, 64.69; H, 5.92; N, 13.72. Found: C, 64.80; H, 6.01; N, 13.86.

*N*-[{4-Ethyl-2-(1-pyrrolyl)-3-furyl}methyl]formamide (**5b**).

The yield was 0.40 g (18%) (white crystals), mp 110°; ir (potassium bromide): ν 3280 (NH), 1645 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.05 (t, 1H, NH), 7.95 (s, 1H, CH), 7.30 (s, 1H, $H_5$), 7.10 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.25 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.01 (s, 2H, $CH_2$), 2.30 (q, 2H, $CH_2$), 1.39 (t, 3H, $CH_3$).

*Anal.* Calcd. for $C_{12}H_{14}N_2O_2$: C, 66.03; H, 6.47; N, 12.84. Found: C, 66.10; H, 6.51; N, 12.90.

*N*-[{4,5-Dimethyl-2-(1-pyrrolyl)-3-furyl}methyl]formamide (**5c**).

The yield was 1.70 g (77%) (white crystals), mp 90°; ir (potassium bromide): ν 3260 (NH), 1640 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.23 (t, 1H, NH), 8.00 (s, 1H, CH), 7.00 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.20 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.00 (s, 2H, $CH_2$), 2.17 (s, 3H, $CH_3$), 1.90 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{12}H_{14}N_2O_2$: C, 66.03; H, 6.47; N, 12.84. Found: C, 66.12; H, 6.52; N, 13.00.

*N*-[{4,5-Diphenyl-2-(1-pyrrolyl)-3-furyl}methyl]formamide (**5d**).

The yield was 1.40 g (41%) (white crystals), mp 178°; ir (potassium bromide): ν 3260 (NH), 1650 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.23 (t, 1H, NH), 7.93 (s, 1H, CH), 7.3 (m, 12H, 2 x $C_6H_5$, $H_{2'}$ and $H_{5'}$), 6.37 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.00 (s, 2H, $CH_2$).

*Anal.* Calcd. for $C_{22}H_{18}N_2O_2$: C, 77.17; H, 5.30; N, 8.18. Found: C, 77.23; H, 5.36; N, 8.24.

*N*-[{4,5-Di-*p*-toluyl-2-(1-pyrrolyl)-3-furyl}methyl]formamide (**5e**).

The yield was 1.15 g (31%) (white crystals), mp 136°; ir (potassium bromide): ν 3285 (NH), 1645 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.24 (t, 1H, NH), 7.90 (s, 1H, CH), 7.25 (m, 8H, 2 x $C_6H_4$), 7.09 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.33 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.95 (s, 2H, $CH_2$), 2.35 (s, 3H, $CH_3$), 2.07 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{24}H_{22}N_2O_2$: C, 77.81; H, 5.99; N, 7.56. Found: C, 77.86; H, 6.02; N, 7.64.

*N*-[{4,5-Di-*p*-anisyl-2-(1-pyrrolyl)-3-furyl}methyl]formamide (**5f**).

The yield was 1.95 g (48%) (white crystals), mp 168°, ir (potassium bromide): ν 3290 (NH), 1640 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.15 (t, 1H, NH), 7.92 (s, 1H, CH), 7.30, 7.03 and 6.86 (2 x AB system, 8H, 2 x $C_6H_4$), 7.23 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.33 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.99 (s, 2H, $CH_2$), 3.80 (s, 3H, $CH_3$), 3.72 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{24}H_{22}N_2O_4$: C, 71.62; H, 5.51; N, 6.96. Found: C, 71.70; H, 5.60; N, 7.02.

*N*-[{2-(1-Pyrrolyl)-3-furyl}methyl]acetamides **6a-f**.

General Procedure.

A solution of compound **4** (0.01 mole) in acetic anhydride (30 ml) was heated at reflux for 2 hours. The mixture that reacted was then left to cool overnight, the crystalline precipitate was finally filtered, washed with diethyl oxide and dried to give **6**.

*N*-[{4-Methyl-2-(1-pyrrolyl)-3-furyl}methyl]acetamide (**6a**).

The yield was 1.30 g (60%) (white crystals), mp 114°; ir (potassium bromide): ν 3259 (NH), 1666 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.07 (t, 1H, NH), 7.31 (s, 1H, $H_5$), 7.09 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.25 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.01 (s, 2H, $CH_2$), 1.95 (s, 3H, $CH_3$-4), 1.80 (s, 3H, $CH_3CO$).

*Anal.* Calcd. for $C_{12}H_{14}N_2O_2$: C, 66.03; H, 6.47; N, 12.84. Found: C, 66.13; H, 6.39; N, 12.96.

*N*-[{4-Ethyl-2-(1-pyrrolyl)-3-furyl}methyl]acetamide (**6b**).

The yield was 0.70 g (30%) (white crystals), mp 112°; ir (potassium bromide): ν 3259 (NH), 1651 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.08 (t, 1H, NH), 7.31 (s, 1H, $H_5$), 7.09 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.25 (t, 2H, $H_{3'}$ and $H_{4'}$), 4.01 (d, 2H, $CH_2$), 2.38 (q, 2H, $CH_2$), 1.80 (s, 3H, $CH_3CO$), 1.40 (t, 3H, $CH_3$).

*Anal.* Calcd. for $C_{13}H_{16}N_2O_2$: C, 67.22; H, 6.94; N, 12.05. Found: C, 67.33; H, 7.00; N, 12.12.

*N*-[{4,5-Dimethyl-2-(1-pyrrolyl)-3-furyl}methyl]acetamide (**6c**).

The yield was 1.44 g (62%) (white crystals), mp 150°; ir (potassium bromide): ν 3280 (NH), 1630 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.97 (t, 1H, NH), 7.00 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.20 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.93 (s, 2H, $CH_2$), 2.20 (s, 3H, $CH_3$-5), 1.90 (s, 3H, $CH_3$-4), 1.80 (s, 3H, $CH_3CO$).

*Anal.* Calcd. for $C_{13}H_{16}N_2O_2$: C, 67.22; H, 6.94; N, 12.05. Found: C, 67.40; H, 7.01; N, 12.10.

*N*-[{4,5-Diphenyl-2-(1-pyrrolyl)-3-furyl}methyl]acetamide (**6d**).

The yield was 1.46 g (41%) (white crystals), mp 222°, ir (potassium bromide): ν 3300 (NH), 1640 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.97 (t, 1H, NH), 7.38 (m, 12H, 2 x $C_6H_5$, $H_{2'}$ and $H_{5'}$), 6.33 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.93 (s, 2H, $CH_2$), 1.70 (s, 3H, $CH_3CO$).

*Anal.* Calcd. for $C_{23}H_{20}N_2O_2$: C, 77.50; H, 5.66; N, 7.86. Found: C, 77.48; H, 5.70; N, 8.00.

*N*-[{4,5-Di-*p*-toluyl-2-(1-pyrrolyl)-3-furyl}methyl]acetamide (**6e**).

The yield was 0.96 g (25%) (white crystals), mp 180°; ir (potassium bromide): ν 3310 (NH), 1660 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.02 (t, 1H, NH), 7.25 (m, 8H, 2 x $C_6H_4$) 7.10 (t, 2H, $H_{2'}$ and $H_{5'}$), 6.33 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.89 (s, 2H, $CH_2$), 2.35 (s, 3H, $CH_3$), 2.24 (s, 3H, $CH_3$), 1.71 (s, 3H, $CH_3CO$).

*Anal.* Calcd. for $C_{25}H_{24}N_2O_2$: C, 78.10; H, 6.29; N, 7.29. Found: C, 78.21; H, 6.30; N, 7.36.

*N*-[{4,5-Di-*p*-anisyl-2-(1-pyrrolyl)-3-furyl}methyl]acetamide (**6f**).

The yield was 0.67 g (26%) (white crystals), mp 184°; ir (potassium bromide): ν 3300 (NH), 1630 (C=O) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.97 (t, 1H, NH), 7.23 (m, 10H, 2 x $C_6H_4$, $H_{2'}$ and $H_{5'}$), 6.33 (t, 2H, $H_{3'}$ and $H_{4'}$), 3.90 (s, 2H, $CH_2$), 3.83 (s, 3H, $OCH_3$-5), 3.73 (s, 3H, $OCH_3$-4), 1.70 (s, 3H, $CH_3CO$).

*Anal.* Calcd. for $C_{25}H_{24}N_2O_4$: C, 72.10; H, 5.81; N, 6.73. Found: C, 72.13; H, 5.76; N, 6.84.

4*H*-Furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepines **7a-f** and their Fumarates **9a-f**.

General Procedure.

A solution of formamide **5** (0.01 mole) in phosphoryl chloride (30 ml) was stirred at 40° for 4 hours. The excess of phosphoryl chloride was distilled under reduced pressure and a solid residue was triturated with a sodium hydroxide solution (2*N*, 30 ml). The resulting solid was filtered, washed with water, dried and recrystallized from diethyl ether to give **7**.

To a solution of diazepine **7** (0.2 g) in 2-propanol was added (0.1 g) of fumaric acid, the resulting mixture was heated at reflux for 30 minutes and then allowed to cool at room temperature overnight. The resulting crystals were filtered, washed with diethyl ether and dried. Crystallization from acetonitrile gave **9**.

3-Methyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**7a**) and its fumarate **9a**.

The yield of **7a** was 0.56 g (30%) (yellow crystals), mp 86°; ir (potassium bromide): ν 1670 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.10 (s, 1H, $H_6$), 7.20 (dd, 1H, $H_9$), 6.80 (s, 1H, $H_2$), 6.60 (dd, 1H, $H_7$), 6.30 (dd, 1H, $H_8$), 4.20 (s, 2H, $CH_2$), 2.20 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{11}H_{10}N_2O$: C, 70.95; H, 5.41; N, 15.05. Found: C, 70.82; H, 5.40; N, 15.12.

The yield of **9a** was 0.17 g (52%) (yellow crystals), mp 198°.

*Anal.* Calcd. for $C_{15}H_{14}N_2O_5$: C, 59.60; H, 4.67; N, 9.27. Found: C, 59.52; H, 4.71; N, 9.31.

3-Ethyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**7b**) and its Fumarate **9b**.

The yield of **7b** was 0.34 g (17%) (yellow crystals), mp 72°; ir (potassium bromide): ν 1670 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.15 (s, 1H, $H_6$), 7.19 (dd, 1H, $H_9$), 6.80 (s, 1H, $H_2$), 6.62 (dd, 1H, $H_7$), 6.34 (dd, 1H, $H_8$), 4.18 (s, 2H, $CH_2$), 2.30 (q, 2H, $CH_2$), 1.19 (t, 3H, $CH_3$).

*Anal.* Calcd. for $C_{12}H_{12}N_2O$: C, 71.97; H, 6.04; N, 13.99. Found: C, 72.02; H, 6.10; N, 14.04.

The yield of **9b** was 0.13 g (41%) (yellow crystals), mp 120°.

*Anal.* Calcd. for $C_{16}H_{16}N_2O_5$: C, 60.75; H, 5.10; N, 8.86. Found: C, 60.81; H, 5.12; N, 8.92.

2,3-Dimethyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**7c**) and its Fumarate **9c**.

The yield of **7c** was 0.52 g (26%) (yellow crystals), mp 78°; ir (potassium bromide): ν 1670 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.07 (s, 1H, $H_6$), 7.30 (dd, 1H, $H_9$), 6.63 (dd, 1H, $H_7$), 6.30 (dd, 1H, $H_8$), 4.47 (s, 2H, $CH_2$), 2.17 (s, 3H, $CH_3$), 1.87 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{12}H_{12}N_2O$: C, 71.97; H, 6.04; N, 13.99. Found: C, 71.82; H, 6.10; N, 14.02.

The yield of **9c** was 0.15 g (47%) (yellow crystals), mp 145°.

*Anal.* Calcd. for $C_{16}H_{16}N_2O_5$: C, 60.75; H, 5.10; N, 8.86. Found: C, 60.80; H, 5.12; N, 8.87.

2,3-Diphenyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**7d**) and its Fumarate **9d**.

The yield of **7d** was 1.65 g (51%) (grey crystals), mp 112°; ir (potassium bromide): ν 1660 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.17 (s, 1H, $H_6$), 7.63 (dd, 1H, $H_9$), 7.30 (m, 10H, 2 x $C_6H_5$), 6.77 (dd, 1H, $H_7$), 6.43 (dd, 1H, $H_8$), 4.40 (s, 2H, $CH_2$).

*Anal.* Calcd. for $C_{22}H_{16}N_2O$: C, 81.46; H, 4.97; N, 8.64. Found: C, 81.51; H, 4.72; N, 8.70.

The yield of **9d** was 0.09 g (33%) (orange crystals), mp 220°.

*Anal.* Calcd. for $C_{26}H_{20}N_2O_5$: C, 70.90; H, 4.58; N, 6.36. Found: C, 70.86; H, 4.61; N, 6.41.

2,3-Di-*p*-toluyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**7e**) and its Fumarate **9e**.

The yield of **7e** was 2.40 g (68%) (yellow crystals), mp 114°; ir (potassium bromide): ν 1666 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl

sulfoxide-$d_6$): δ 8.08 (s, 1H, $H_6$), 7.54 (dd, 1H, $H_9$), 7.17 (m, 8H, 2 x $C_6H_4$), 6.69 (dd, 1H, $H_7$), 6.35 (dd, 1H, $H_8$), 4.30 (s, 2H, $CH_2$), 2.27 (s, 3H, $CH_3$), 2.14 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{24}H_{20}N_2O$: C, 81.79; H, 5.72; N, 7.95. Found: C, 82.00; H, 5.61; N, 8.00.

The yield of **9e** was 0.12 g (45%) (brown crystals), mp 222°.

*Anal.* Calcd. for $C_{28}H_{24}N_2O_5$: C, 71.78; H, 5.16; N, 5.98. Found: C, 71.80; H, 5.21; N, 6.04.

2,3-Di-*p*-anisyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**7f**) and its Fumarate **9f**.

The yield of **7f** was 1.43 g (37%) (yellow crystals), mp 110°; ir (potassium bromide): ν 1666 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 8.13 (s, 1H, $H_6$), 7.33 (dd, 1H, $H_9$), 6.97 (m, 8H, 2 x $C_6H_4$), 6.53 (dd, 1H, $H_7$), 6.30 (dd, 1H, $H_8$), 4.50 (s, 2H, $CH_2$), 3.83 (s, 3H, $CH_3$), 3.70 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{24}H_{20}N_2O_3$: C, 74.98; H, 5.24; N, 7.29. Found: C, 74.91; H, 5.30; N, 7.10.

The yield of **9f** was 0.08 g (30%) (orange crystals), mp 220°.

*Anal.* Calcd. for $C_{28}H_{24}N_2O_7$: C, 67.19; H, 4.83; N, 5.60. Found: C, 67.23; H, 4.92; N, 5.73.

6-Methyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepines **8a-f** and their Fumarates **10a-f**.

General Procedure.

As described above treatment of acetamides **6** in phosphoryl chloride gave compounds **8** which were obtained either as oily compounds or solid compounds recrystalllized in diethyl ether. Fumarates **10** were obtained as above.

3,6-Dimethyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**8a**) and its Fumarate **10a**.

The yield of **8a** was 0.80 g (40%) (orange oil); ir (potassium bromide): ν 1670 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.20 (dd, 1H, $H_9$), 6.80 (s, 1H, $H_2$), 6.60 (dd, 1H, $H_7$), 6.40 (dd, 1H, $H_8$), 4.30 (s, 2H, $CH_2$), 2.20 (s, 3H, $CH_3$), 2.18 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{12}H_{12}N_2O$: C, 71.97; H, 6.04; N, 13.99. Found: C, 72.01; H, 6.09; N, 14.12.

The yield of **10a** was 0.07 g (22%) (yellow crystals), mp 130°.

*Anal.* Calcd. for $C_{16}H_{16}N_2O_5$: C, 60.75; H, 5.10; N, 8.86. Found: C, 60.72; H, 5.08; N, 8.92.

3-Ethyl-6-methyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**8b**) and its Fumarate **10b**.

The yield of **8b** was 1.03 g (48%) (red oil); ir (potassium bromide): ν 1676 (C=N) $cm^{-1}$; $^1H$ nmr (deuteriochloroform): δ 7.23 (dd, 1H, $H_9$), 6.97 (s, 1H, $H_2$), 6.63 (dd, 1H, $H_7$), 6.30 (dd, 1H, $H_8$), 4.30 (s, 2H, $CH_2$), 2.33 (m, 5H, $CH_2$ and $CH_3$), 1.20 (t, 3H, $CH_3$).

*Anal.* Calcd. for $C_{13}H_{14}N_2O$: C, 72.87; H, 6.59; N, 13.08. Found: C, 73.00; H, 6.52; N, 13.20.

The yield of **10b** was 0.07 g (22%) (brown crystals), mp 160°.

*Anal.* Calcd. for $C_{17}H_{18}N_2O_5$: C, 61.81; H, 5.49; N, 8.48. Found: C, 61.91; H, 5.48; N, 8.60.

2,3,6-Trimethyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**8c**) and its Fumarate **10c**.

The yield of **8c** was 1.03 g (48%) (brown oil), ir (potassium bromide): ν 1670 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.00 (dd, 1H, $H_9$), 6.40 (dd, 1H, $H_7$), 6.07 (dd, 1H, $H_8$), 4.10 (s, 2H, $CH_2$), 2.20 (s, 3H, $CH_3$), 2.10 (s, 3H, $CH_3$), 1.83 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{13}H_{14}N_2O$: C, 72.87; H, 6.59; N, 13.08. Found: C, 72.90; H, 6.60; N, 13.21.

The yield of **10c** was 0.03 g (10%) (yellow crystals), mp 168°.

*Anal.* Calcd. for $C_{17}H_{18}N_2O_5$: C, 61.81; H, 5.49; N, 8.48. Found: C, 61.99; H, 5.51; N, 8.60.

2,3-Diphenyl-6-methyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]diazepine (**8d**) and its Fumarate (**10d**).

The yield of **8d** was 2.50 g (74%) (red oil); ir (potassium bromide): ν 1660 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.63 (dd, 1H, $H_9$), 7.33 (m, 10H, 2 x $C_6H_5$), 6.87 (dd, 1H, $H_7$), 6.43 (dd, 1H, $H_8$), 4.13 (s, 2H, $CH_2$), 2.23 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{23}H_{18}N_2O$: C, 81.63; H, 5.36; N, 8.28. Found: C, 81.62; H, 5.40; N, 8.32.

The yield of **10d** was 0.11 g (40%) (yellow crystals), mp 166°.

*Anal.* Calcd. for $C_{27}H_{22}N_2O_5$: C, 71.35; H, 4.88; N, 6.16. Found: C, 71.09; H, 4.80; N, 6.34.

2,3-Di-*p*-toluyl-6-methyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]-diazepine (**8e**) and its Fumarate (**10e**).

The yield of **8e** was 2.20 g (60%) (yellow crystals), mp 118°; ir (potassium bromide): ν 1666 (C=N) $cm^{-1}$; $^1H$ nmr (dimethyl sulfoxide-$d_6$): δ 7.62 (dd, 1H, $H_9$), 7.20 (m, 8H, 2 x $C_6H_4$), 6.86 (dd, 1H, $H_8$), 6.45 (dd, 1H, $H_7$), 4.13 (s, 2H, $CH_2$), 2.35 (s, 3H, $CH_3$), 2.26 (s, 3H, $CH_3$), 2.23 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{25}H_{22}N_2O$: C, 81.93; H, 6.05; N, 7.65. Found: C, 82.01; H, 6.10; N, 7.81.

The yield of **10e** was 0.08 g (30%) (orange crystals), mp 200°.

*Anal.* Calcd. for $C_{29}H_{26}N_2O_5$: C, 72.18; H, 5.43; N, 5.81. Found: C, 72.20; H, 5.46; N, 5.72.

2,3-Di-*p*-anisyl-6-methyl-4*H*-furo[3,2-*f*]pyrrolo[1,2-*a*][1,4]-diazepine (**8f**) and its Fumarate (**10f**).

The yield of **8f** was 1.20 g (30%) (yellow crystals), mp 130°; ir (potassium bromide): ν 1666 (C=N) $cm^{-1}$; $^1H$ nmr (deuteriochloroform): δ 7.40 (dd, 1H, $H_9$), 6.97 (m, 8H, 2 x $C_6H_4$), 6.70 (dd, 1H, $H_7$), 6.37 (dd, 1H, $H_8$), 4.23 (s, 2H, $CH_2$), 3.83 (s, 3H, $CH_3$), 3.77 (s, 3H, $CH_3$), 2.37 (s, 3H, $CH_3$).

*Anal.* Calcd. for $C_{25}H_{22}N_2O_3$: C, 75.35; H, 5.57; N, 7.03. Found: C, 75.41; H, 5.60; N, 7.00.

The yield of **10f** was 0.13 g (50%) (orange crystals), mp 200°.

*Anal.* Calcd. for $C_{29}H_{26}N_2O_7$: C, 67.69; H, 5.09; N, 5.45. Found: C, 67.52; H, 5.12; N, 5.60.

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